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Investigation of the CVCS Letdown Line Break Effect on Safety-Related Electric Equipment in the Kori Unit 1 Auxiliary Building

Jin Yong Lee[a], Byung Chul Lee[a], Young Suk Bang[a], Jae Won Park[b] and Jae Sik Jeong[b]

[a]*FNC Technology Co., Ltd.,*
SNU RPIC #516, San 4-2 Bongchun7-dong, Gwanak-gu, Seoul 151-818, Republic of Korea
Jinyong1@fnctech.com
[b]*Korea Power Engineering Company,*
360-9 Mabuk-dong, Giheung-gu, Yongin-si,Gyenggi-do, 449-713, Republic of Korea

1. Introduction

The time-dependent temperature at the location of the electric equipment important to safety must be established for the design basis accident during or following which this equipment is required to remain functional.

In the Kori Unit 1 auxiliary building, electric equipment such as 120V vital instrument panel(XPN-218) and SFP MPP40A/B local panel(XPN-25) is installed at EL. 20 ft area but the thermal hydraulic conditions and its influence on the equipment have not been properly investigated under CVCS letdown line break accident conditions[1].

The objectives of this study are to examine closely the influence of CVCS letdown break accident at the location of electric equipment in the Kori Unit 1 auxiliary building and to assess whether the equipment maintains its function under the accident conditions.

2. Analysis Methods

2.1 Analysis Model

Based on the design drawings and data obtained from an actual inspection, multi-compartment Lumped Parameter(LP) and subdivided(3D) GOTHIC 6.1b[2] analysis models were developed.

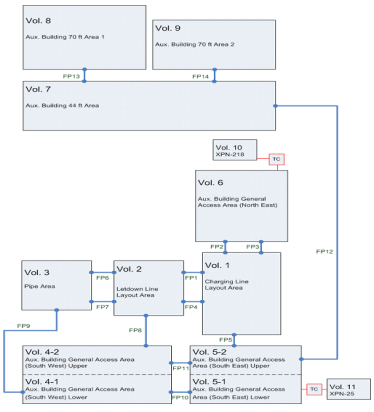

Fig. 1 Schematic of GOTHIC 6.1b LP model

Fig. 1 shows a schematic of the GOTHIC 6.1b LP model. Nodes 1 to 6 represent the EL. 20 ft areas of Kori Unit 1 aux. building. Node 7 is the EL. 44 ft area and Nodes 8 and 9 represent the EL.70 ft areas. Nodes 10 and 11 represent the XPN-218 and XPN-25 panel, respectively. Mass and energy source from the CVCS letdown line is injected to the node 2, which is the location of the letdown line containment wall penetration.

By integrating the EL. 20 ft areas of LP model and subdividing the area into 8,736 cells, GOTHIC 6.1b 3D model was established. Fig. 2 represents the division of EL. 20 ft area. In the 3D model, major structure such as concrete walls, tanks was modeled with null cells.

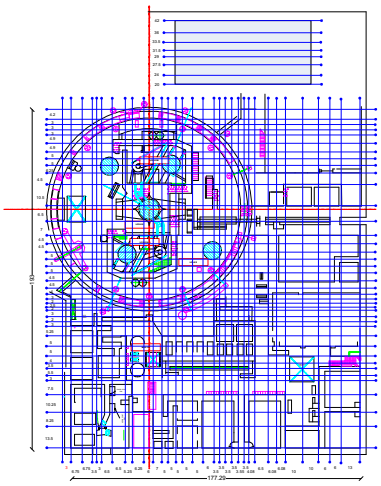

Fig. 2 Division of EL. 20 ft area for 3D model

2.2 Analysis Conditions

The mass and energy release data by break of CVCS letdown line are obtained from the calculations of RELAP5/MOD3 code. Two cases are considered. One is when the letdown line is operated at the normal conditions(N.O.) and the other is for maximum purification operation(M.P.O.) of the system.

The initial temperature and pressure for auxiliary building are set to 104 ^{o}F, 14.6 psia, respectively. And the initial relative humidity is set to 7 %.

3. Analysis Results

Fig. 3 shows the temperature profiles of EL. 20 ft areas by letdown line break during normal operation. And, Fig 4 represents the analysis results in case that the letdown line breaks during maximum purification operation. In both cases, temperature of whole region of EL. 20 ft exceeded 120 ^{o}F. The temperature of the letdown line layout area(Node 2) was highest. On the other hand, the temperatures of NE general area(Node 6) and SE general area(Node 5-1) were relatively low.

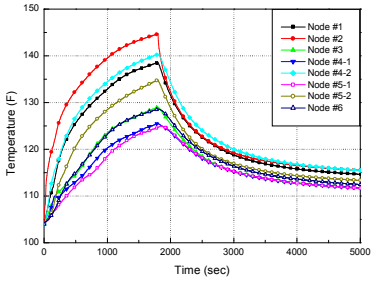

Fig. 3 Analysis results(LP model, N.O.)

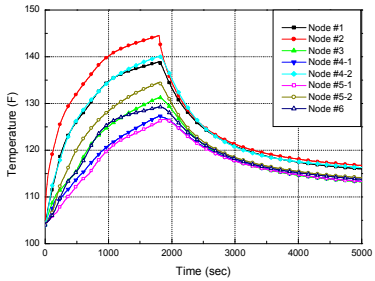

Fig. 4 Analysis results(LP model, M.P.O.)

In order to assess whether the electric panels remain to be functional under letdown line break conditions, thermal lag analyses were performed using GOTHIC LP model.

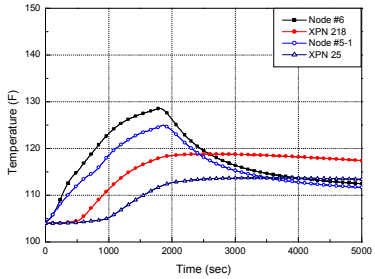

Fig. 5 Analysis results(Thermal lag, N.O.)

Fig. 5 and Fig. 6 show the results of thermal lag analysis. In all cases, the inside temperature of panels was kept below 120 ^{o}F. Fig. 7 shows the analysis results of 3D model which indicates the 120 ^{o}F and 130 ^{o}F iso-surfaces in EL. 20 ft area. The steam of high temperature diffused from break point to SW general area and then raised the ambient region temperature. Because of the buoyancy, the temperature rose from high region to low region. In particular, the NE general area(Node 6 in LP model) temperature was significantly low compared with the LP analysis results because the area was hardly affected source momentum and the flow path between this area and charging line layout area(Node 1 in LP model) was located at low elevation.

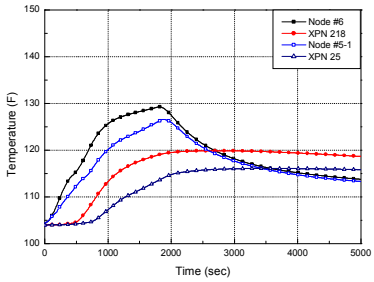

Fig. 6 Analysis results(Thermal lag, M.P.O.)

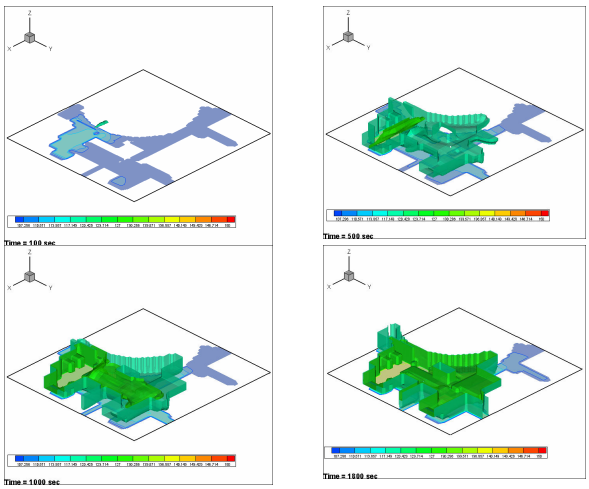

Fig. 7 Analysis results(3D model, M.P.O.)

4. Conclusions

In order to investigate the CVCS letdown line break effect on safety-related electric panel in Kori Unit 1 aux. building, analysis models were developed with GOTHIC 6.1b code and temperature distribution analyses and thermal lag analyses were performed.

The analyses results showed that the temperatures of most of area in aux. building EL. 20 ft exceeded 120 ^{o}F but the inside temperature of the panel remained below that value under the letdown line break conditions. From the 3D analysis results, the NE general area could keep mild condition during and following the accident. If the panel XPN-25 is relocated at NE general area or SE general area lower region, it can be concluded that the electric panels will maintain its function during and following CVCS letdown line break accident.

REFERENCES

[1] T.L.George et al., GOTHIC Containment Analysis Package Technical Manual-Version 6.1b, NAI, 2001.
[2] Kori Unit 1, Final Safety Analysis Report, KHNP.